The refinement attainable is not equal to that reached in the case of inorganic compounds. One cannot think of working with millionths of milligrams, and will at times have to be content if a satisfactory result is reached with tenths of milligrams. The classes of compounds dealt with, in this first number of the book, are: 1. The anthracene group; 2. Phenols; 3. Nitro-compounds; 4. Quinones, Ketones, Aldehydes. It is to be hoped that the appearance of the book will lead chemists to try the new methods, as it appears that their work will be much facilitated by them. It must, of course, be borne in mind that the problem of detecting minute quantities of organic compounds does not often present itself, though there are cases in which it becomes of importance. IRA REMSEN.

On the Densities of Oxygen and Hydrogen and on the Ratio of their Atomic Weights. By EDWARD W. MORLEY, Ph. D. Published by the Smithsonian Institution, Washington, D. C. 1895. 4°. xi. 117 pp.

For more than ten years Prof. Morley has been almost constantly engaged on the work which is described in this paper. With a painstaking fidelity to the highest ideals of accurate work which has rarely been equalled and has never been surpassed, he has determined four constants which are partly interdependent, and which are of very great importance in physical science. These constants are: the density of hydrogen, the density of oxygen, the ratio of the combining volumes and the ratio of the combining weights of the two elements.

The density of oxygen was determined by three different methods.

In the first series nine determinations were made. From nine to twenty-one and one-half liters of oxygen were weighed in large globes which were filled at the temperature of the laboratory.

In the second series sixteen determinations were made. Instead of measuring the temperature and pressure directly in this series the oxygen was brought to the same temperature and pressure as that of hydrogen contained in another large globe. The pressure of the hydrogen was previously measured at the temperature of melting ice, thus making the globe containing it, in effect, a very sensitive air thermometer. The difference between the coefficients of expansion of hydrogen and of oxygen was of course considered.

In the third series seventeen determinations were made. The globes were filled at the temperature of melting ice and, after weighing them filled with oxygen, they were exhausted and weighed again. The oxygen in this series was prepared partly from potassium chlorate and partly by the electrolysis of dilute sulphuric acid.

The results of three series were:

By use of thermometer and manometer	$D = 1.42879$
By compensation	$D = 1.42887$
By use of ice and barometer	$D = 1.42917$

Giving double weight to the last series, the weight of a liter of oxygen under normal conditions at sea level and in latitude 45° is 1.42900 grm., with a probable error of 0.000034 grm.

Five series of determinations of the density of hydrogen were made.

In the first and second series the same methods were used as in the first and third series for oxygen.

In the third, fourth and fifth series hydrogen was absorbed in palladium, contained in a glass tube, and, after weighing, was expelled into three globes which were surrounded with melting ice, and which had a combined capacity of forty-two liters. By this means three and seven-tenths grams of hydrogen were weighed in a comparatively small apparatus, and the volume occupied by the gas was accurately determined. The method has the additional advantage that any mercurial vapor contained in the globes was without effect on the determination. In all, sixty-four determinations were made. The results were as follows:

Series	I.	$D = 0.089938$
"	II.	$D = 0.089970$
"	III.	$D = 0.089886 \pm 0.0000049$
"	IV.	$D = 0.089880 \pm 0.0000088$
"	V.	$D = 0.089866 \pm 0.0000034$

It is believed that mercurial vapor entered the globes in the first two series and that the results of those series are too high. They are accordingly rejected. The remaining series give as the weight of a liter of hydrogen at sea

level in latitude 45° and under normal conditions, 0.089873 ± 0.0000027.

In 1891 Prof. Morley published* a series of determinations of the volumetric composition of water. The results of these determinations were extremely concordant and there can be no reasonable doubt that the same ratio would be obtained again by the same method. When, however, this ratio is combined with the ratio of the densities given above, the resulting value for the atomic weight of oxygen does not agree with that which Prof. Morley has obtained by the direct weighing of oxygen and hydrogen and of the water formed by their union. Scott has recently determined† the volumetric ratio and finds the value 2.00285. This ratio, when combined with the ratio of densities as found either by Lord Rayleigh or by Prof. Morley, gives the same value for the atomic weight as that found by the gravimetric method. Prof. Morley has, therefore, determined the volumetric ratio by another method. In a series of ten experiments he determined the density of electrolytic gas obtained from a solution of caustic potash. He also determined the excess of hydrogen present in the gas. From the results obtained, and, taking into account the change in pressure occasioned when one volume of oxygen is mixed with two volumes of hydrogen and the mixture is made to occupy three volumes, the value 2.00269 for the volumetric ratio was calculated.

It seems to be established, therefore, that the values obtained by Prof. Morley with the eudiometer were not correct as representing the volumetric ratio and that the density of a gas in a tube is different from that in a globe, the effect on the density being different for a light gas from that for a heavy one.

The gravimetric composition of water was determined in a series of twelve experiments. In these the oxygen was weighed in large globes, the hydrogen (three and one-half grams), in palladium, and the two gases were burned in an apparatus so devised that the water formed was also weighed. In this way each experiment gave two independent determinations of the atomic weight of oxygen.

* Amer. Journ. of Science, *41*, 220.

† Phil. Trans. *184*, A, 543 (1893).

The results were:

From the ratio of hydrogen and oxygen,	15.8792
From the ratio of hydrogen and water,	15.8785

These values agree to the third decimal with the value calculated from the volumetric composition and the ratio of densities as given above.

The final results of Prof. Morley's determinations are:

	Grams.
Weight of one liter of oxygen, latitude 45°,	1.42900
Weight of one liter of hydrogen, latitude 45°,	0.089873
Atomic weight of oxygen, chemical method,	15.879
Atomic weight of oxygen, physical methods,	15.879
Molecular weight of water, chemical method,	17.879

In conclusion a summary of previous determinations of the constants in question is given. Omitting the earlier determinations, which were manifestly inaccurate, and the results of one more recent experimenter, whose work appears to have been affected by some source of constant error, the mean of all the other determinations of six different observers gives the value 15.879 for the atomic weight of oxygen.

It is impossible, in a brief sketch of this kind, to convey any adequate idea of the pains which was taken at every step to secure the greatest possible accuracy in the work, nor of the genius which has been displayed in devising complicated apparatus adapted for the determinations to be made. The work is classical and must, hereafter, be consulted by every one who wishes to do the best work in this field.

W. A. Noyes.

EIMER'S EVOLUTION OF BUTTERFLIES.*

Prof. Eimer, of Tübingen, is an enthusiastic opponent of Darwin's theory of Natural Selection, and has a theory of his own to replace it. The theory of Eimer has been defended by him on various occasions, his main exposition being given in his work on the origin of species published in 1888. His investigations on butterflies (thus far of the genus Papilio *auct.* only) are intended to afford proof of his theory in a

* Die Artbildung und Verwandtschaft bei den Schmetterlingen. II. Theil. von Dr. G. H. Theodor Eimer unter Mitwirkung von K. Fickert. Text 8vo. Pp. viii, 153. Atlas Folio Tafeln v.–viii. Jena, Gustav Fischer. 1895.